Integrated tuner circuit with antenna control

This integrated tuner circuit (2) for radiofrequency signals is suitable to be connected to at least one antenna (22), wherein the integrated circuit comprises an internal resonance stage (10) with at least one trimmable capacitance (12) adapted to be connected to the antenna and to resonate therewith and wherein the integrated circuit also comprises a control unit (20) adapted to control the value of said at least one trimmable capacitance to change the resonance value of the antenna.

FIG. 1A
Description

[0001] The present invention relates to integrated tuner circuits with antenna control. Radio frequency transmissions generally require a large bandwidth. For example, the transmission range according to the DVB-H standard extends from about 470 MHz to 890 MHz. However, most commonly used antennas have a small bandwidth sensibility of about 200 or 300 MHz.

[0002] To address this difference, two main approaches have been developed.

[0003] A first type of integrated tuner circuits uses several switched antennas, each with a different bandwidth sensibility. For example, a first antenna is set for a range extending from 470 to 600 MHz and a second antenna is set for a range extending from 600 to 890 MHz. These tuners require specific additional components to control the antennas as well as internal and external components to ensure the switching between the antennas.

[0004] Another type of integrated tuner circuits uses external antenna resonance stages with capacitances resonating with the antenna to set the reception range by setting the frequency of maximum resonance. Such external antenna resonance stages usually use PIN diodes or varactor diodes and require an extra voltage supply.

[0005] None of these solutions is satisfactory as they both require many external components.

[0006] Another problem of the known integrated tuner circuits is that they have very few adaptation capacities and are designed only for one type of antenna.

[0007] One advantage of the present invention is to solve these problems and provide an efficient integrated tuner circuit with antenna control with increased adaptation capacities.

[0008] To this effect, the invention recites an integrated tuner circuit according to claim 1. Thanks to the use of an internal resonance stage with a trimable capacitance, this integrated tuner circuit has increased adaptation capacities.

[0009] Other features and advantages of the invention will be apparent from the description illustrated by the drawings in which:

- Figures 1A and 1B represent two uses of a first embodiment of the invention; and
- Figure 2 represents a second embodiment of the invention.

[0010] With reference to figures 1A and 1B, a first integrated tuner circuit 2 according to the invention will now be described. This integrated tuner circuit has an interface module 4 with inputs and outputs terminals, also called bond pads. In the example, the interface module 4 has at least one input terminal IN, one output terminal OUT and a ground terminal GND.

[0011] The integrated tuner circuit has an internal amplifier stage 6 connected to the input terminal IN and a voltage generator 8 connected to the output terminal OUT.

[0012] The integrated tuner circuit of the invention also comprises an internal resonance stage 10 connected to the output terminal OUT and to the ground terminal GND.

[0013] In the embodiment described, the internal resonance stage 10 comprises a trimable capacitance 12 connected to the output terminal OUT and connected to a ground through the ground terminal.

[0014] Furthermore, the integrated tuner circuit 2 comprises a switch 14 connected between the voltage generator 8 and the output terminal OUT.

[0015] The integrated tuner circuit 2 also comprises a control module 20 adapted to digitally control the switch 14 and the value of the trimable capacitance 12.

[0016] Besides these elements, the integrated tuner circuit comprises classical tuner components not represented.

[0017] Figure 1A represents a first use of this integrated tuner circuit in which an external antenna 22, such as a classical 50 ohms antenna, is connected to the input terminal IN and the output terminal OUT.

[0018] Advantageously, a balance and matching module 24, used to compensate for impedance imperfections of the antenna 22, is connected between the antenna 22 and the input terminal IN.

[0019] In this embodiment, the switch 14 disconnects the voltage generator 8 from the output terminal OUT, leaving connected only the trimable capacitance of the internal resonance circuit 2.

[0020] Accordingly, the trimable capacitance 12 is connected between the ground and the antenna 22 to achieve a L-C tank setting the maximum resonance value of the antenna and the reception range. Thus, the control of the value of the capacitance 12 by the control module 20, allows a digital setting of the reception range of the antenna 6.

[0021] In another use of the same integrated tuner circuit 2, represented with reference to figure 1B, an external resonance stage 30 is used.

[0022] This external resonance stage 30 is connected between the antenna 22, the output terminal OUT and the balance and matching module 24. To enable this external resonance circuit 30, the switch 14 connects the voltage generator 8 to the output terminal OUT.

[0023] More precisely, the external resonance stage 30 comprises a varactor diode 32 connected between the antenna 22 and a first terminal of a capacitance 34 in order to establish a voltage between the antenna and the output of the varactor diode. The second terminal of said capacitance 34 is connected to the ground. A first resistor 36 is connected between the balance and matching module 24 and the second terminal of the capacitance 34.

[0024] The variations of voltage over this external resonance stage 30 change the range of maximal reception by changing the value for which the maximal resonance of the antenna 22 is reached. More precisely, the external...
resonance stage 30 and the antenna 22 create an L-C tank which resonance frequency is set by controlling the varactor diode 32.

[0025] The use of such an external resonance stage is classical and will not be described in more details.

[0026] In this embodiment, the resonance is set by both the external resonance stage 30 powered by the voltage generator 8 and the internal resonance stage 10.

[0027] Internal resistor 38 isolates the impedance of the external circuit 30 from the output impedance of the voltage generator 8 and the switch 14.

[0028] Thus, the integrated tuner circuit of the invention can be connected to an antenna, with or without an external antenna resonance stage, with good adaptation capacities. The control of the internal trimable capacitance allows tuning of the reception range of the antenna by changing its resonance value. The use of the internal switch 14 and the voltage generator allows to enable and to disable the external resonance stage and thus allows combining the tuner of the invention with existing circuitry including such an external resonance stage without any modification of this existing circuitry.

[0029] With reference to figure 2, another embodiment of the invention will now be described. In this embodiment, similar components are designed with the same references as in the previous embodiment.

[0030] In this example, the integrated tuner circuit 2 comprises only the internal antenna resonance stage and no voltage generator and thus, is not adapted to provide power to an external resonance stage.

[0031] Each of the inputs INA and INB is connected to an internal switch stage 40 which is also connected to the output terminal OUTB, thus the switch stage 40 is able to connect the output terminal OUTB to one or the other of the input terminals INA and INB.

[0032] The integrated tuner circuit also comprises the elements described above, namely, the internal resonance stage 10, the control module 20, the amplification stage 6, the voltage generator 8 and the switch 14. In this embodiment, the amplification stage 6 is connected to the terminal INC and the control module 20 is also adapted to control the internal switch stage 40. Furthermore, the switch 14 to open to disable the voltage generator 8 and the terminal OUTA is directly connected to the terminal INA.

[0033] When used, this integrated tuner circuit is connected to two antennas 42A and 42B, each adapted to receive a specific range of the frequency spectrum.

[0034] More precisely, each of the inputs INA and INB is connected to a respective antenna 42A and 42B, thus, the antenna 42A is also connected to the internal resonance stage through the terminal OUTA.

[0035] The output terminal OUTB is connected to the balance and matching module 24 which output is fed to the amplification stage 6 through the terminal INC.

[0036] Depending upon the switch stage 40, the integrated tuner circuit 2 uses the antenna 42A or the antenna 42B directly.

[0037] Furthermore, due to the use of the internal switch 14, this tuner can be used with existing external resonance stages.

[0038] When the antenna 42A is used, the resonance value is set by the internal resonance stage 10 as described with reference to Figure 1A when the antenna 42B is used, the resonance value is set in a classical manner.

[0039] Thus, the integrated tuner circuit of the invention can be used to adjust the reception range of an antenna due to its internal trimable capacitance. It can also be used with existing external resonance circuits and several antennas thanks to the internal switches.

[0040] Of course other embodiments are also possible.

[0041] Advantageously, the tuner comprises a unit monitoring the quality of the signal inputs and outputs. This monitoring unit provides the control module with quality information used to set the reception range by changing the value of the trimable capacitance and/or selecting the antenna.

[0042] In another embodiment, the control unit receives configuration information to set the reception range.

[0043] Advantageously the trimable capacitance is a specific capacitance such as a Metal Insulator Metal (MIM) capacitance to reduce the current loss between the antenna and the ground.

[0044] In one embodiment, the internal capacitance is digitally trimmed by use of several individual capacitances connected in parallel, each of them being series connected with a transistor used as a switch and digitally controlled. Accordingly, the digital control of the transistors allows the control of the overall value of the capacitance.

[0045] In another example, the integrated tuner circuit comprises only the internal antenna resonance stage and no voltage generator and thus, is not adapted to provide power to an external resonance stage.

[0046] In another embodiment, the matching and balance module is integrated in the tuner.

[0047] Still in another embodiment, when two antennas are used, each of them is connected to an internal resonance stage. If the same internal resonance stage is used, a switch connecting the internal resonance stage to one or the other of the antennas is added. Furthermore, each antenna can also be connected to an external resonance stage.

[0048] Other embodiments and combination of the ones described can also be achieved.

Claims

1. Integrated tuner circuit (2) for radiofrequency signals suitable to be connected to at least one antenna (22: 42A, 42B), wherein the integrated circuit comprises an internal resonance stage (10) with at least one trimable capacitance (12) adapted to be connected
to the antenna and to resonate therewith and where-
in the integrated circuit also comprises a control unit
(20) adapted to control the value of said at least one
trimable capacitance to change the resonance value
of the antenna.

2. Integrated tuner circuit according to claim 1, wherein
said trimable capacitance of said internal resonance
stage is connected between a terminal (OUT; OUT
A) of the integrated tuner circuit adapted to be con-
ected to an antenna (22; 42A, 42B) and a terminal
adapted to be connected to a ground (GND).

3. Integrated tuner circuit according to claim 1, being
further suitable to be connected to an external res-
onance stage (30), wherein the integrated circuit
comprises a voltage generator (8) adapted to enable
said external resonance stage.

4. Integrated tuner circuit according to claim 3, further
comprising an internal switch (14) to connect or dis-
connect said voltage generator.

5. Integrated tuner circuit according to claim 4, wherein
said trimable capacitance is connected to a terminal
(OUT) of said integrated tuner circuit and said volt-
age generator (8) is connected to the same terminal
of the integrated tuner circuit through said internal
switch (14).

6. Integrated tuner circuit according to any one of
claims 1 to 5, wherein said control unit (20) is adapted
to receive configuration information and to control
the value of the trimable capacitance depending up-
on said configuration information.

7. Integrated tuner circuit according to any one of
claims 1 to 6, wherein said control unit (20) is adapted
to receive transmission quality information and to
control the value of the trimable capacitance depend-
ing upon said transmission quality information.

8. Integrated tuner circuit according to any one of
claims 1 to 7, further adapted to be connected to
several antennas (42A, 42B) and comprising an in-
ternal switch stage (40) to switch between said an-
tennas, said internal resonance stage (10) being
suitable to be connected to at least one of said an-
tennas.

9. Integrated tuner circuit according to any one of
claims 1 to 8, wherein said trimable capacitance is
formed of several individual capacitances connected
in parallel, each individual capacitance being series
connected with a transistor functioning as a switch.

10. Integrated tuner circuit according to any one of
claims 1 to 9, wherein said trimable capacitance
comprises at least one Metal Insulator Metal capac-
itance.
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document with indication, where appropriate, of relevant passages</th>
<th>Relevant to claim</th>
<th>CLASSIFICATION OF THE APPLICATION (IPC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>DE 43 32 798 A1 (TELEFUNKEN MICROELECTRON [DE]) 30 March 1995 (1995-03-30)</td>
<td>1,6</td>
<td>INV. H03J3/00</td>
</tr>
<tr>
<td>Y</td>
<td>* column 1, line 39 - column 2, line 26</td>
<td>2,7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>* column 3, line 21 - column 4, line 38</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* column 5, line 22 - line 27</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>* column 7, line 1 - line 41</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>WO 00/42585 A (SOUNDCRAFT INC [US], WATKINS RANDY [US]) 20 July 2000 (2000-07-20)</td>
<td>1-3,5,6,9</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>* figure 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>* figures 4,11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>US 5 349 700 A (PARKER ROBERT P [US]) 20 September 1994 (1994-09-20)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The present search report has been drawn up for all claims.

The Hague 29 November 2006

Peeters, Mark

CATEGORY OF CITED DOCUMENTS
X: particularly relevant if taken alone
Y: particularly relevant if combined with another document of the same category
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: earlier patent document, but published on, or after the filing date
D: document cited in the application
L: document cited for other reasons
&: member of the same patent family, corresponding document
# ANNEX TO THE EUROPEAN SEARCH REPORT
## ON EUROPEAN PATENT APPLICATION NO. EP 06 29 1118

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-11-2006

<table>
<thead>
<tr>
<th>Patent document cited in search report</th>
<th>Publication date</th>
<th>Patent family member(s)</th>
<th>Publication date</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE 4332798 A1</td>
<td>30-03-1995</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 3788427 T2</td>
<td>24-03-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HK 9197 A</td>
<td>31-01-1997</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 6030462 B</td>
<td>20-04-1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2500633 T</td>
<td>01-03-1990</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 8805214 A1</td>
<td>14-07-1988</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AU 2404700 A</td>
<td>01-08-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2360298 A1</td>
<td>20-07-2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1367915 A</td>
<td>04-09-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1696956 A</td>
<td>16-11-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1145203 A1</td>
<td>17-10-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HK 1048551 A1</td>
<td>01-09-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2002535860 T</td>
<td>22-10-2002</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 6317027 B1</td>
<td>13-11-2001</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 200106429 A</td>
<td>10-09-2002</td>
</tr>
<tr>
<td>US 2003119469 A1</td>
<td>26-06-2003</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>US 6133834 A</td>
<td>17-10-2000</td>
<td>NONE</td>
<td></td>
</tr>
<tr>
<td>WO 2005006579 A</td>
<td>20-01-2005</td>
<td>CN 1823476 A</td>
<td>23-08-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KR 20060029688 A</td>
<td>06-04-2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SE 525659 C2</td>
<td>29-03-2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SE 0302054 A</td>
<td>12-01-2005</td>
</tr>
</tbody>
</table>

For more details about this annex: see Official Journal of the European Patent Office, No. 12/82